# Novel Directional Solidification Processing of Hypermonotectic Alloys

Charles R. Baugher/ES71
205–544–7417
E-mail: charles.baugher@msfc.nasa.gov

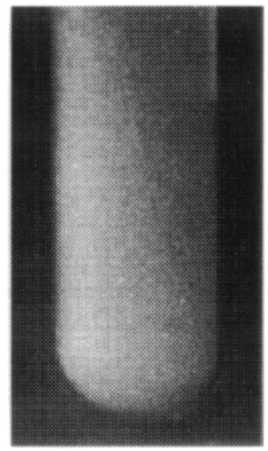
***Special Notice:*** *This research task is being performed as a part of the cooperative agreement for microgravity research between MSFC, the Universities Space Research Association, and the University of Alabama, Huntsville. The principle investigator for the investigation is: Richard N. Grugel/USRA 205–544–9165*

The proposed investigation has several scientific objectives which will be realized by conducting a systematic experimental investigation in conjunction with a thorough modeling effort. The theoretical study will develop a semiquantitative predictive model relating microstructure to process parameters for the systems investigated experimentally. This will require close interaction with the experiment in order to determine more precisely the role of the various dynamic processes induced by ultrasound in these monotectic systems. Experimentally, ultrasound will be utilized to suspend and maintain separation of the liquid II (glycerol) droplets which precipitate from the bulk once the temperature drops below the miscibility gap boundary so that a uniformly aligned hypermonotectic composite might actually be produced by controlled directional solidification. This concept is demonstrated with a hypermonotectic, succinonitrile-glycerol mixture, figures 124 and 125.

The systematic, controlled directional solidification, experimental investigation will utilize a series of alloy compositions ranging from the monotectic reaction to well into the miscibility gap. Two sample sets will be investigated, one in conjunction with ultrasonics and one, otherwise identically processed, without. Metallographic examination will provide information regarding phase spacings, phase distributions, and volume fractions. The model will pay particular attention to the nature of the ultrasonic waves, including reflection and refraction of longitudinal waves and the two-liquid phase boundary, and on the importance of standing waves. Evaluation of the model and analysis of the data will provide valuable guidelines for optimizing a microgravity experiment.

Subsequent examination of the processed samples will promote our understanding of diffusion and coalescence processes, liquid-liquid interactions, wetting phenomena, and microstructural development. The liquid volume fraction ultrasonics can maintain dispersed versus the coalescing (settling) force imposed by gravity will be determined and then evaluated whether or not this could be improved upon in a microgravity environment. The value of this work will be a demonstration and mathematical characterization of a novel solidification processing technique. The knowledge acquired

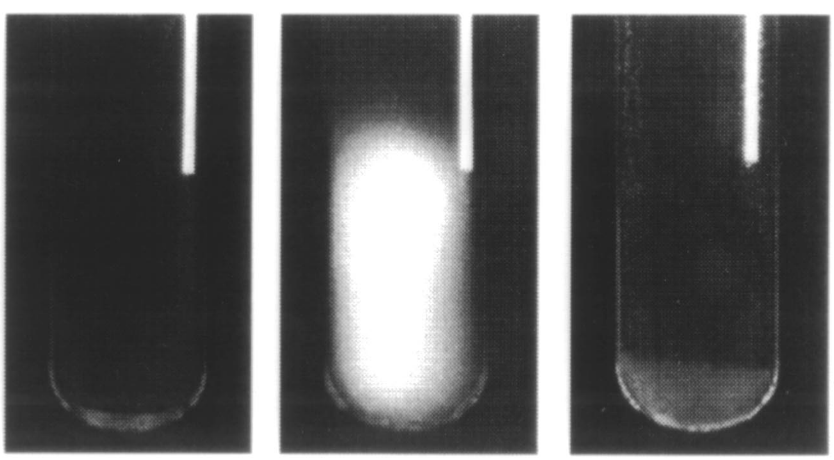
Temperature (°C)
50



105
Time (min)

**FIGURE 125.—Photograph showing a well-maintained dispersion of the liquid II phase in the presence of an applied ultrasonic field.**

Temperature (°C)
73.8 67.3 50.7



0 9 45
Time (min)

**FIGURE 124.—Time sequence as a function of decreasing temperature showing precipitation and settling of liquid II (glycerol) from the bulk liquid.**

from investigating model alloys might then be applied to technologically relevant miscibility gap systems, e.g., superconducting Cu-Ba-Y, with the potential of producing novel composites having improved properties.

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**Biographical Sketch:** Charles Baugher is a materials scientist and deputy division chief in the Microgravity Science and Applications Division of Space Sciences Laboratory. His recent research has been in the area of defining the low-level acceleration environment of the Space Shuttle during microgravity experimentation and in studying effects of that environment on materials processing. He has been published in the areas of electromagnetic propagation in plasmas, the interactions of plasmas with spacecraft, astronomical observations in the infrared, and the morphology of the Earth's magnetosphere.